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Validation of a Self-Reported Measure of Household Food Insufficiency with Nutrient Intake Data

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Validation of a Self-Reported Measure of Household Food Insufficiency with Nutrient Intake Data. By Donald Rose and Victor Oliveira. U.S. Department of Agriculture, Economic Research Service, Food and Consumer Economics Division. Technical Bulletin 1863.

Abstract

In order to improve our understanding of self-reported indicators of food insecurity and hunger, this study examined the external validity of one such measure using nutrient intake data from the 1989-91 Continuing Survey of Food Intake by Individuals (CSFII). Food-insufficient households were defined as those reporting that they sometimes or often did not get enough to eat (n=299); the rest of sample households were classified as food-sufficient (n=5,844). Nutrient adequacy ratios, using intake data obtained from 24-hour diet recalls and age- and sex-specific Recommended Dietary Allowances, were calculated for 15 nutrients and averaged at the household level. Multiple regression analysis was used to study the association of food sufficiency with these indicators of nutrient intake, while controlling for other influences on dietary patterns, such as age, race-ethnicity, and schooling of the household head; income status, size and composition of the household; and geographic and seasonal influences on diet. Net of these influences on diet, mean intake of energy by households reporting food insufficiency was 13 percent lower than for food-sufficient households. Food insufficiency was also associated with a significantly decreased intake of 13 other nutrients – relative differences ranging from 8 to 18 percent of consumption levels in food-sufficient households. These findings further validate the use of self-reported measures of food insecurity and hunger.

Keywords: Food insecurity, hunger, food insufficiency, nutrient intake, Continuing Survey of Food Intake by Individuals (CSFII)

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Introduction

Since 1992, the Food and Consumer Service of USDA, in collaboration with the National Center for Health Statistics of the Department of Health and Human Services (DHHS), has supported extensive research to develop survey-based measures of food insecurity and hunger in the United States (USDA, DHHS, 1994). The work expands on previous developments in this field pioneered by various researchers at universities, health departments, and public advocacy groups (Radimer et al., 1992; Briefel and Woteki, 1992; Wehler et al., 1991). In part, these developments in hunger measurement were stimulated by the Report of the President's Task Force on Food Assistance, published in 1984. The report found evidence of hunger, but was unable to estimate the extent of the problem or how it had changed in recent years, due to a lack of adequate indicators.

The current effort to define and measure food insecurity and hunger is part of the 10-Year Plan for National Nutrition Monitoring and Related Research, a plan mandated by PL 101-445.[1] In recent years, consensus has formed on conceptual definitions of food insecurity and hunger, which are expressed in a report prepared for the American Institute of Nutrition on nutritional status indicators of low-income populations (FASEB/LSRO, 1990).[2] At the core of the current effort to operationalize this definition is a questionnaire – the Food Security Supplement to the Current Population Survey (CPS). Fielded in April 1995, this instrument will provide the most comprehensive nationally representative source of information on household food insecurity and hunger in the United States to date (Bickel, Andrews, and Klein, 1996).

Validation studies are needed of any new measure, whether the indicator comes from the social or biological sciences. Much of the recent research on food insecurity has addressed this need. For example, researchers at Cornell University have validated hunger and food insecurity measures by comparing them to other indicators of household food availability and socio-economic status in a sample of households from upstate New York (Kendall, Olson, and Frongillo, 1995). The Community Childhood Hunger Identification Project, sponsored by the Food Research and Action Center, has surveyed over 7,000 low-income families in 17 States using a different questionnaire (Wehler et al., 1995; Wehler et al., 1991). This instrument was also subjected to external validity testing with a sample of low-income households from Seattle, WA (Wehler, Scott, and Anderson, 1992).

Most validation studies have compared measures of food insecurity with other social or economic indicators such as household income in relation to the poverty threshold. Few studies have looked at hunger measures in terms of other nutritional indicators that form part of the national nutrition monitoring system. Although this is an important choice for comparison, both conceptual and methodological difficulties hamper such research.

[1] PL 101-445 is known as the National Nutrition Monitoring and Related Research Act of 1990.

[2] Food security is defined in this report as "access by all people at all times to enough food for an active, healthy life and includes at a minimum: a) the ready availability of nutritionally adequate and safe foods, and b) the assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, and other coping strategies)."

The main conceptual issue concerns the distinctions among food insecurity, hunger, and malnutrition. Food insecurity "exists whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain" (FASEB/LSRO, 1990). Hunger is a potential consequence of this food insecurity and implies that those affected experience physical symptoms and are unable to alleviate those symptoms due to resource constraints. Malnutrition is evidenced by various anthropometric, biochemical, and/or clinical signs, such as growth stunting in children, low blood hemoglobin, or in severe cases, the muscle wasting associated with protein-energy malnutrition.

Although hunger can lead to malnutrition, the two are conceptually distinct; there is no reason to believe that indicators for one should be relied on to validate indicators for the other. In fact, domestic food insecurity and hunger are largely hidden phenomena because those who suffer from them do not necessarily show the obvious symptoms associated with malnutrition. Hunger can be periodic – days without food – or it can be prolonged but at a low level – for example, the chronic skipping of meals. Food insecurity and hunger can also involve poor adaptations, such as reliance on low-quality diets that have little variety and may be lacking in nutrients.

Hunger, however, does imply relative food deprivation and indicators of dietary intake in the national nutrition monitoring system are available to address this issue. For example, nutrient adequacy ratios – the intake of specific nutrients in relation to age- and sex-specific Recommended Dietary Allowances (RDA's) – would be a likely choice to monitor hunger. But because of the nature of hunger and food insecurity, dietary intake information cannot be used to measure hunger definitively. Typically, intakes are obtained using a 24-hour recall, either by itself or in combination with a second 24-hour recall or a 2-day food record. These intervals may simply be too short to register food deprivation that is intermittent. However, it is plausible, given large enough sample sizes, that group estimates of dietary intakes for those who have experienced hunger would be lower than for those not experiencing hunger. Such evidence could provide external validation for self-reported measures of hunger and food insecurity.

Only one previous national study, based on the 1985 and 1986 Continuing Surveys of Food Intake by Individuals (CSFII), has examined nutrient intake with regard to self-reported hunger or food insecurity. The study found that women age 19 to 50 from households reporting food insufficiency consumed less nutrients than those from food-sufficient households (Cristofar and Basiotis, 1992). However, this work was not based on multivariate analysis, so that differences in nutrient intakes could have been due to other social or economic characteristics that affect diet beyond food insufficiency. In addition, due to survey design, conclusions could not be drawn about all household members; only two individual types – adult women and their preschool children – were studied.

This report seeks to validate a common self-reported measure of food insecurity and hunger with dietary intake data. We use data from a more recent and comprehensive version of the CSFII to quantify the relationship between food insufficiency and nutrient intake, controlling for a number of factors thought to have an effect on diet.

As used here, "food insufficiency" is an indicator based on the response by the household head to the question:

> Which one of the following statements best describes the food eaten in your household: enough of the kinds of food we want to eat; enough but not always what we want to eat; sometimes not enough to eat; or often not enough to eat?

Households reporting that they sometimes or often do not get enough to eat are termed "food-insufficient." Although this indicator is not as sophisticated as the CPS measure being developed to monitor food insecurity and hunger, it provides a link to this new measure and may turn out to be a reasonable proxy for resource-constrained hunger. The "food sufficiency" question, as it has come to be known, has been used in USDA surveys since the mid-1970's to measure food deprivation and is well established in prior analytic research (Blaylock and Smallwood, 1986; Blaylock, 1987; Basiotis, 1992).

Unlike the previous CSFII work, we look at the relationship between food insufficiency and nutrient intake at a household level, consistent with the newly developed CPS indicator of food insecurity and hunger. The 1989-91 CSFII allows for this type of analysis, since the survey attempted to collect dietary information on all household members.

Methods

Study Sample

The analyses presented here are based on data obtained from the 1989-91 CSFII. The survey was conducted by the U.S. Department of Agriculture's Human Nutrition Information Service (HNIS) and forms an integral part of the National Nutrition Monitoring and Related Research Program (FASEB/LSRO, 1995). The CSFII was based on two independent stratified clustered samples of housing units – a basic, or all-income sample, and a low-income sample. The samples were drawn from the 48 coterminous States and Washington, DC (USDA, 1992). Detailed descriptions of sampling procedures and response rates have been published elsewhere (Tippett et al., 1995).

For the analysis of nutrient intake data at the household level, we included all households from both samples in which at least half of the eligible members had dietary intake data. We defined eligible members as those individuals who were 1 year old or older, who were not currently breast-feeding, and who were not bedridden. Boarders and employees living in the household were excluded, as the CSFII did not collect dietary information on these individuals. By these criteria, 6,179 (92 percent) of the 6,718 households participating in the CSFII provided usable intake data. Eight of these households with intake data were missing data on food sufficiency status and an additional 28 households were missing data on years of schooling of the household head, which was used as an independent variable in our multivariate analyses. The final sample for the household analyses contained complete data on 6,143 households, 91 percent of participating households.

During development of the new Current Population Survey (CPS) food insecurity measure, analyses were performed on three different types of households to ensure that this new measure would be applicable across the entire population. To assess whether our validation of the food sufficiency proxy would also be applicable across various household types, we conducted additional separate analyses using these same household types. The three household types analyzed were those with children under 18 years of age (n=2,335); those without children, but with elderly individuals 60 years old and older (n=2,082); and those with neither children nor elderly individuals (n=1,726).

Dietary Data

The CSFII collected individual dietary intake data for 3 days. A 24-hour recall was used on the first day, while the last 2 days were based on a food record. In order to maximize the number of usable observations and to maintain consistency with other dietary surveys, this study was based exclusively on the first day of dietary data.

The amounts of nutrients in each food were calculated using the weight of the food consumed and the nutritive value of that food. The latter information was obtained from a nutrient data base developed by HNIS and containing approximately 6,700 items (Perloff et al., 1990; USDA, 1985).

Dependent variables used here are the intakes of nutrients from food sources and are expressed as household nutrient adequacy ratios. The intake of a nutrient by an individual was divided by the age- and sex-specific RDA for that individual and expressed in percentage terms (NRC/FNB, 1989). For energy, intake was divided by the recommended energy intake for a reference person engaged in light to moderate activity. These individual nutrient adequacy ratios were averaged within a household to derive a household nutrient adequacy ratio. Nutrients studied in these analyses include food energy, protein, vitamin A, vitamin E, vitamin C, thiamin, riboflavin, niacin, vitamin B-6, folate, calcium, phosphorus, magnesium, iron, and zinc.

Food Insufficiency

Household respondents were asked, "Which one of the following statements best describes the food eaten in your household: (1) Enough of the kinds of food we want to eat; (2) Enough but not always what we want to eat; (3) Sometimes not enough to eat; or

Table 1--Mean nutrient intakes of food-sufficient and food-insufficient households in the United States, 1989-91[1]

Public health priority[2]	Nutrient	Intake (% of RDA) Food-sufficient (n = 5,844)	Food-insufficient[3] (n = 299)
		Mean (SE)	
Current	Food energy	79.8 (0.7)	68.3 (2.8)*
	Calcium	87.8 (1.1)	79.8 (6.8)
	Iron	124.2 (1.5)	99.3 (5.1)*
Potential	Protein	147.7 (1.1)	145.0 (7.0)
	Vitamin A	120.3 (2.1)	93.6 (8.6)*
	Vitamin E	89.7 (1.4)	61.2 (3.6)*
	Vitamin C	168.4 (2.5)	133.6 (17.6)
	Vitamin B-6	96.4 (0.8)	81.1 (4.3)*
	Folate	151.0 (2.0)	142.1 (8.6)
	Phosphorus	137.8 (1.3)	120.9 (8.8)
	Magnesium	91.1 (0.9)	82.7 (3.8)*
	Zinc	80.7 (0.9)	68.9 (3.3)*
Not current	Thiamin	125.4 (1.2)	107.5 (5.1)*
	Riboflavin	131.3 (1.3)	116.2 (5.8)*
	Niacin	135.7 (1.3)	114.1 (5.4)*
Summary[4]	MAR14	83.9 (0.3)	73.1 (1.8)*

[1] Nutrient intakes of individuals reporting 1 day of dietary information were divided by their RDA's and averaged for each household. Group means were calculated using these household averages and the CSFII 1989-91 household weights.

[2] This classification is based on the monitoring priority status for nutrients in the *Third Report on Nutrition Monitoring in the United States* (FASEB/LSRO, 1995).

[3] Food insufficiency is defined by the household respondent's report that there is sometimes or often not enough to eat.

[4] MAR14 is a summary measure of dietary quality based on the mean adequacy ratio (Guthrie and Sheer, 1981). It is an average of the intakes, as a percent of the RDA, of all nutrients in the table other than energy.

* Indicates statistically significant (P<.05) difference in intake between food-sufficient and food-insufficient households.

(4) Often not enough to eat?" Households in the last two categories were combined into one group and termed "food-insufficient," a convention that has been adopted in other research on this topic (Alaimo and Briefel, 1994; Rose, Blaylock, and Basiotis, 1994; Cristofar and Basiotis, 1992).

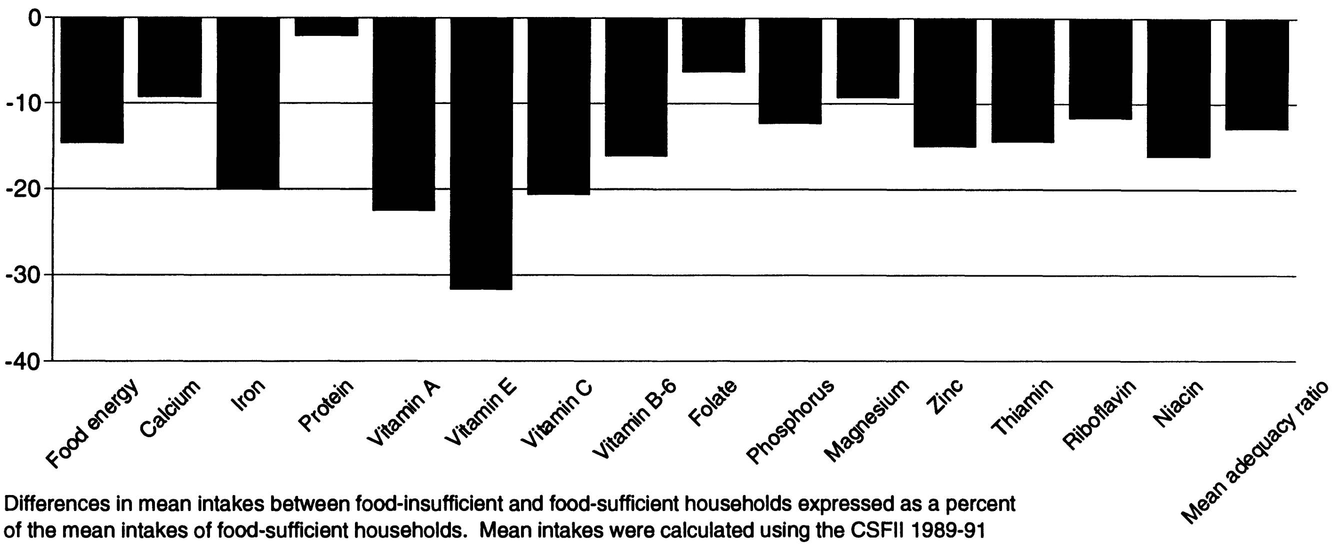
Socio-Demographic and Economic Variables

Dietary intake is influenced by a number of social, cultural, and economic factors. In order to assess the quantitative relationship between food insufficiency and intake, it was important to control for these confounding variables. Race and ethnicity were incorporated into three dichotomous variables, which indicated whether the household head was a Hispanic, a non-Hispanic Black, or from another racial-ethnic group; the reference group for these variables was non-Hispanic Whites.

Household structure was described using several variables. An indicator variable was used to control for households headed by a single adult; households headed by two adults served as the reference. Household size and age of the household head were also used, in quadratic form, as independent variables. Number of years of schooling completed by the household head was used to control for educational background. In households headed by two adults, the average age and years of schooling for both heads were used.

Figure 1

Difference in nutrient intakes between food-insufficient and food-sufficient households in the United States, 1989-92



Differences in mean intakes between food-insufficient and food-sufficient households expressed as a percent of the mean intakes of food-sufficient households. Mean intakes were calculated using the CSFII 1989-91 3-year household weights.

A number of variables were used to describe the economic circumstances of the household. For each household, per capita annual income from the previous year was used in a quadratic form as an independent variable in multiple regression analyses. A dichotomous variable indicating home ownership was used as a measure of wealth. Another dichotomous variable indicated participation in any of three USDA food assistance programs: the Food Stamp, the National School Lunch, or the WIC Program.

In order to account for differences in regional food consumption habits and prices, three dichotomous variables were used to indicate whether households were in the Northeast, the South, or the West; those in the Midwest were the reference. Indicator variables were also used to control for urbanization; that is, whether the household was located in a central city, a nonmetropolitan area, or a suburb (reference group).

Several variables accounted for the effects of time on food consumption. A dichotomous variable was used to indicate whether the 24-hour recall was obtained on a weekend day. Three variables were used to control for seasonal differences in food consumption by indicating whether the observation was in the second, third, or fourth quarter of the year; the first quarter was the reference. Two variables were also used to control for the year of the interview – 1990 or 1991 – with 1989 as the reference.

Statistical Methods

Descriptive statistics in table 1 and figure 1 were weighted using the 3-year household weights included with the CSFII (USDA, 1992). For our estimates of standard errors in table 1, we accounted for the complex sample design with a replicate sample technique, balanced repeated replication, used under WesVarPC (Westat, 1996).

In order to control for the influence of socio-demographic and economic factors on dietary intakes, single-equation multivariate regression analyses were performed using the Statistical Analysis System (SAS Institute, 1990). In these analyses, the nutrient adequacy ratios were the dependent variables and the independent variables were food insufficiency status and all socioeconomic variables described above. The differences in mean nutrient intakes between food-insufficient and food-sufficient households, while controlling for the socioeconomic variables, are reported in tables 3–6. We use the term *food*

Table 2--Selected socioeconomic characteristics of the study samples[1]

	All (n = 6,143)	Households w/children < 18 (n = 2,335)	w/elderly 60+ (n = 2,082)[2]	w/neither children nor elderly (n = 1,726)
		Mean		
Household size (persons)	2.5	4.0	3.6	1.7
Household income (dollars)	22,614	24,475	16,824	27,082
Age of head (years)	49.0	36.3	70.7	40.1
Schooling of head (years)	11.7	11.9	10.6	12.7
		Percent		
Food-insufficient household	4.9	7.2	2.7	4.4
Single-headed household	46.2	31.7	56.6	53.2
Owns home	57.9	51.0	73.7	8.0
Participates in food assistance program	21.6	43.8	8.5	7.1
Race/ethnicity of head:				
Non-Hispanic White	76.1	68.0	83.4	78.4
Non-Hispanic Black	13.9	17.7	11.1	11.9
Hispanic	7.6	11.0	4.3	7.0
Other	2.4	3.3	1.2	2.7
Urbanization:				
Central city	30.9	32.4	28.9	31.2
Suburb	41.5	41.8	38.7	44.6
Nonmetropolitan	27.6	25.8	32.4	24.2
Region:				
Northeast	19.5	18.5	21.7	18.1
South	37.4	35.6	40.6	35.9
West	19.4	19.2	17.8	21.7
Midwest	23.7	26.7	19.9	24.3

[1] Figures in this table are unweighted sample means.

[2] This group does not include households with children under 18 years of age. Households with both children and elderly members are included in the "Households with children" group.

insufficiency gap to refer to those differences in mean intakes due exclusively to food insufficiency, that is, net of other influences. These differences are partial regression coefficients, specifically, the coefficients on the food insufficiency indicator variables in the above regressions.

The use of sampling weights in regression models can lead to an inefficient analysis. Following Korn and Graubard (1991), we calculated the approximate inefficiency of including the sample weights in our analysis to be 47 percent. Accordingly, we used unweighted regression analysis and included variables in our models that were used to determine the sampling weights, including sex, race, education, household demographic and economic conditions, region, urbanization, and year of the survey.

Results

The mean intake of energy for food-insufficient households was 68.3 percent of the Recommended Energy Intake and was significantly ($P < 0.05$) lower than consumption by food-sufficient households. To highlight the public health relevance of other nutrients that we studied, nutrients in table 1 were grouped into three categories based on recommendations prepared for the Interagency Board for Nutrition Monitoring and Related Research (FASEB/LSRO, 1995).[3] While the intakes of all nutrients were lower among the food-insufficient,

[3] Nutrients were considered to be either "current," "potential," or "not current" public health issues based on intakes in the population and evidence of adverse health conditions associated with these nutrients.

Table 3--Food insufficiency gap: Differences in nutrient intakes between food-insufficient and food-sufficient households net of other influences on diet, all households (n = 6,143)

Public health priority[1]	Nutrient	Intake difference[2] (% of RDA)	P	Relative difference[3] (%)
Current	Food energy	-10.0	0.000	-12.8
	Calcium	-6.7	0.018	-8.0
	Iron	-11.5	0.008	-9.7
Potential	Protein	-15.0	0.000	-10.3
	Vitamin A	-12.6	0.126	-10.8
	Vitamin E	-15.4	0.000	-18.4
	Vitamin C	-21.4	0.007	-13.5
	Vitamin B-6	-13.1	0.000	-13.9
	Folate	-15.7	0.007	-10.5
	Phosphorus	-12.2	0.000	-9.3
	Magnesium	-10.1	0.000	-11.3
	Zinc	-7.0	0.011	-9.0
Not current	Thiamin	-15.4	0.000	-12.4
	Riboflavin	-12.4	0.001	-9.6
	Niacin	-14.6	0.000	-11.1
Summary[4]	MAR14	-7.7	0.000	-9.3

[1] This classification is based on the monitoring priority status for nutrients in the *Third Report on Nutrition Monitoring in the United States* (FASEB/LSRO, 1995).

[2] Difference in mean intakes between food-insufficient and food-sufficient households, while controlling for other factors that affect diet. These partial regression coefficients were estimated from single-equation unweighted regression models in which nutrient intakes were regressed on the food insufficiency indicator and socioeconomic control variables described in the text.

[3] Intake difference as a percent of food-sufficient group's mean intake.

[4] MAR14 is a summary measure of dietary quality based on the mean adequacy ratio (Guthrie and Sheer, 1981). It is an average of the intakes, as a percent of the RDA, of all nutrients in the table.

P = Probability of these results occurring under the null hypothesis (no difference between the food-sufficient and food-insufficient groups). When P is less than 0.05, as it is for most nutrients, the null hypothesis is rejected in favor of the alternative hypothesis, that there is indeed a difference between the two groups.

this difference was statistically significant for 9 of the 14 other nutrients we studied, including iron, magnesium, zinc, and vitamins A, E, and B-6.

To examine overall diet quality, we created a composite measure based on the concept of the mean adequacy ratio (Guthrie and Sheer, 1981). Nutrient adequacy ratios were averaged together after being truncated at 100 percent.[4] MAR14 is the variable name in table 1 of the mean adequacy ratio for the 14 nutrients that we investigated. The food-insufficient consumed a significantly lower quality diet, as measured by this index.

As can be seen in figure 1, the relative difference in household nutrient intakes between the two groups was greater than 10 percent for 11 of the 15 nutrients studied. Food-insufficient households consumed about 20 percent less iron and about 32 percent less vitamin E than food-sufficient households.

Descriptive statistics for the different samples of households used in this study are shown in table 2. About 5 percent of all sample households reported food insufficiency, while about 7 percent of households with children under age 18 reported food insufficiency. This rate was lower in the samples of

[4] By definition, all nutrients are essential, so that excess intakes of one nutrient cannot make up for low intakes of another. Truncation at 100 percent of the RDA reflects this biological reality.

Table 4--Food insufficiency gap: Differences in nutrient intakes between food-insufficient and food-sufficient households net of other influences on diet, households with children less than 18 years (n = 2,335)

Public health priority[1]	Nutrient	Intake difference[2] (% of RDA)	P	Relative difference[3] (%)
Current	Food energy	-9.4	0.000	-11.4
	Calcium	-10.4	0.002	-11.5
	Iron	-11.5	0.008	10.4
Potential	Protein	-16.3	0.003	-9.1
	Vitamin A	-6.5	0.433	-5.8
	Vitamin E	-10.4	0.024	-12.7
	Vitamin C	-30.6	0.001	-18.7
	Vitamin B-6	-11.2	0.002	-11.3
	Folate	-10.0	0.235	-5.6
	Phosphorus	-16.3	0.000	-12.2
	Magnesium	-10.0	0.005	-9.4
	Zinc	-9.9	0.002	-12.1
Not current	Thiamin	-10.5	0.013	-8.2
	Riboflavin	-10.9	0.014	-7.8
	Niacin	-10.8	0.008	-8.3
Summary[4]	MAR14	-6.0	0.000	-7.0

[1] This classification is based on the monitoring priority status for nutrients in the *Third Report on Nutrition Monitoring in the United States* (FASEB/LSRO, 1995).

[2] Difference in mean intakes between food-insufficient and food-sufficient households, while controlling for other factors that affect diet. These partial regression coefficients were estimated from single-equation unweighted regression models in which nutrient intakes were regressed on the food insufficiency indicator and socioeconomic control variables described in the text.

[3] Intake difference as a percent of food-sufficient group's mean intake.

[4] MAR14 is a summary measure of dietary quality based on the mean adequacy ratio (Guthrie and Sheer, 1981). It is an average of the intakes, as a percent of the RDA, of all nutrients in the table.

P = Probability of these results occurring under the null hypothesis (no difference between the food-sufficient and food-insufficient groups). When P is less than 0.05, as it is for most nutrients, the null hypothesis is rejected in favor of the alternative hypothesis, that there is indeed a difference between the two groups.

households without children; about 3 percent of elderly households and 4 percent of nonelderly households reported food insufficiency. These statistics (and all others in table 2) describe the samples used in our analyses and are not U.S. population estimates.

To quantify the association of food insufficiency with nutrient intakes, we estimated the difference in nutrient adequacy ratios between food-sufficient and food-insufficient households while controlling for a number of factors that influence diet. Table 3 presents the results of these estimations, which we refer to as the *food insufficiency gap*, for all households in our sample. Households reporting food insufficiency consume about 13 percent less food energy than food-sufficient households. Mean intakes of calcium and iron – nutrients that represent "current" public health issues – are significantly lower in food-insufficient households. All nutrients that represent "potential" public health issues, except vitamin A, are significantly lower in food-insufficient households. Where differences are statistically significant, the decrease in average household intakes associated with food insufficiency ranges from about 8 to 18 percent in relative terms. Our composite measure, MAR14, also showed that food insufficiency is significantly associated with a lower quality diet.

Tables 4-6 present the results of similar regression analyses, but run separately on each of three household types: those with children under 18 years of age;

Table 5--Food insufficiency gap: Differences in nutrient intakes between food-insufficient and food-sufficient households net of other influences on diet, households with elderly persons, 60 years and older (n = 2,082)

Public health priority[1]	Nutrient	Intake difference[2] (% of RDA)	P	Relative difference[3] (%)
Current	Food energy	-9.2	0.023	-12.3
	Calcium	-4.3	0.485	-5.5
	Iron	-16.9	0.114	-13.3
Potential	Protein	-11.1	0.108	-9.5
	Vitamin A	-32.1	0.166	-24.5
	Vitamin E	-21.4	0.059	-25.5
	Vitamin C	-11.7	0.539	-7.4
	Vitamin B-6	-14.2	0.044	-15.5
	Folate	-21.4	0.090	-16.2
	Phosphorus	-7.6	0.300	-6.1
	Magnesium	-5.8	0.204	-7.5
	Zinc	-5.3	0.426	-7.4
Not current	Thiamin	-17.5	0.045	-13.9
	Riboflavin	-12.4	0.174	-9.7
	Niacin	-23.7	0.010	-17.5
Summary[4]	MAR14	-8.7	0.001	-10.9

[1] This classification is based on the monitoring priority status for nutrients in the *Third Report on Nutrition Monitoring in the United States* (FASEB/LSRO, 1995).

[2] Difference in mean intakes between food-insufficient and food-sufficient households, while controlling for other factors that affect diet. These partial regression coefficients were estimated from single-equation unweighted regression models in which nutrient intakes were regressed on the food insufficiency indicator and socioeconomic control variables described in the text.

[3] Intake difference as a percent of food-sufficient group's mean intake.

[4] MAR14 is a summary measure of dietary quality based on the mean adequacy ratio (Guthrie and Sheer, 1981). It is an average of the intakes, as a percent of the RDA, of all nutrients in the table.

P = Probability of these results occurring under the null hypothesis (no difference between the food-sufficient and food-insufficient groups). When P is less than 0.05, as it is for most nutrients, the null hypothesis is rejected in favor of the alternative hypothesis, that there is indeed a difference between the two groups.

those without children, but with adults aged 60 or older; and those with neither children nor elderly individuals. For all three types, food energy intake is lower among households reporting food insufficiency than among food-sufficient households. For households with children, the relative difference is 11 percent; for those with elderly persons, 12 percent; for those with neither children nor elderly persons, 18 percent.

Food-insufficient households of the three demographic types also consumed significantly less than their food-sufficient counterparts, according to our composite measure of diet quality. The relative decrease in diet quality associated with food sufficiency was about 7 percent for households with children and about 11 and 14 percent, respectively, for elderly and nonchild/nonelderly households. The difference in intakes associated with food insufficiency is negative for all nutrients studied. For households with children, 13 of these differences are statistically significant (at $P < 0.05$, see column 2); for those with elderly persons and those with neither children nor elderly persons, the differences are statistically significant for 4 and 8 nutrients.

Discussion

These analyses clearly indicate that households reporting food insufficiency consume lower amounts of nutrients than do those from households where food sufficiency is not a problem. In the multivariate models, food insufficiency is associated with a sig-

Table 6--Food insufficiency gap: Differences in nutrient intakes between food-insufficient and food-sufficient households net of other influences on diet, households with neither children nor elderly persons (n = 1,726)

Public health priority[1]	Nutrient	Intake difference[2] (% of RDA)	P	Relative difference[3] (%)
Current	Food energy	-13.8	0.001	-17.7
	Calcium	-1.2	0.856	-1.5
	Iron	-13.7	0.170	-11.4
Potential	Protein	-13.8	0.064	-10.2
	Vitamin A	-20.9	0.191	-19.9
	Vitamin E	-25.1	0.006	-28.8
	Vitamin C	-15.3	0.356	-10.2
	Vitamin B-6	-17.6	0.003	-19.4
	Folate	-23.2	0.034	-18.2
	Phosphorus	-9.7	0.251	-7.0
	Magnesium	-11.4	0.011	-14.3
	Zinc	-6.7	0.257	-8.6
Not current	Thiamin	-25.1	0.000	-21.6
	Riboflavin	-17.9	0.019	-14.9
	Niacin	-17.7	0.019	-13.6
Summary[4]	MAR14	-10.8	0.000	-13.6

[1] This classification is based on the monitoring priority status for nutrients in the *Third Report on Nutrition Monitoring in the United States* (FASEB/LSRO, 1995).

[2] Difference in mean intakes between food-insufficient and food-sufficient households, while controlling for other factors that affect diet. These partial regression coefficients were estimated from single-equation unweighted regression models in which nutrient intakes were regressed on the food insufficiency indicator and socioeconomic control variables described in the text.

[3] Intake difference as a percent of food-sufficient group's mean intake.

[4] MAR14 is a summary measure of dietary quality based on the mean adequacy ratio (Guthrie and Sheer, 1981). It is an average of the intakes, as a percent of the RDA, of all nutrients in the table.

P = Probability of these results occurring under the null hypothesis (no difference between the food-sufficient and food-insufficient groups). When P is less than 0.05, as it is for most nutrients, the null hypothesis is rejected in favor of the alternative hypothesis, that there is indeed a difference between the two groups.

nificantly lower intake of food energy and 13 other nutrients, including calcium and iron, which are of particular concern for public health in the United States. Controlling for other factors, energy intake is 13 percent lower in food-insufficient households than it is in food-sufficient households. For the other nutrients studied, the food insufficiency gap in relative terms is from 8 to 18 percent.

Our analyses of these relationships by specific household type are broadly consistent with the findings from our all-household sample. That is, households reporting food insufficiency, regardless of demographic type, consume significantly less food energy and have lower diet quality, as measured by the mean adequacy ratio, than food-sufficient households. The degree of difference on these measures, as well as on the specific nutrient adequacy ratios, does vary by household type. For energy and overall diet quality, the relative difference in intake associated with food insufficiency is greatest for households with neither children nor elderly persons and least for households with children. However, dietary patterns are complex and these relationships are not consistent across all nutrients. For example, the difference in calcium intakes between food sufficiency groups is greatest for households with children and least for households with neither children nor elderly persons – a pattern opposite that for food energy.

Although our research differed in a number of methodological aspects with previous research that analyzed nutrient intakes by food sufficiency status, there are some broad similarities in the findings.

Using data from the 1985-86 CSFII, Cristofar and Basiotis (1992) found that women reporting food insufficiency consumed significantly less energy and less of 11 other nutrients than food-sufficient women. They concluded that individuals, on average, have the ability to reliably estimate food sufficiency status.

The principal focus of the 1985-86 CSFII was women age 19 to 50. One concern from the work on these data was whether the women in this survey, when asked the household food sufficiency question, were able to distinguish their own situations from those of their households. In other words, for the food-insufficient, was there a net shortfall of food for the entire household or were those answering the question reporting on their own individual situation in a household with the same amount of food, but unequally distributed? Since the earlier CSFII did not collect nutrient intake data on all household members, there was no way to answer this question.

The 1989-91 CSFII did attempt to collect data on all household members. We find that there was a lower nutrient intake, when assessed at the household level, for those households whose respondents reported food insufficiency.

One limitation of our research is that analyses were based on a single 24-hour recall, an instrument that is less reliable at describing usual intake than multiple dietary recalls (Sempos et al., 1985). In addition to the normal day-to-day variability in dietary practices, those experiencing food shortages may have increased variability in intakes associated with limited financial resources and monthly cash-flow problems. The increased variability introduced by these factors should not affect our estimates of mean intakes. However, it would increase the size of our confidence intervals around these estimates, making it less likely to find significant differences that might exist between food sufficiency groups. In this sense, our results can be considered conservative. Despite the limitations of the 24-hour recall, it continues to be an instrument that is relied upon for population estimates of intake in the national nutrition monitoring system (FASEB/LSRO, 1995).

Another potential limitation of this research is that we used ordinary least squares regression analysis rather than two-stage least squares or another instrumental variable technique. It is possible that our food insufficiency variable is correlated with the error terms in our regression equations; unobserved factors, or omitted variables, which affect both food insufficiency and dietary intake, could bias our estimates (Pindyck and Rubinfeld, 1981). However, to limit this potential bias, we have attempted to include all relevant and available independent variables in these regressions.[5] We may be at the limits of analytic tractability with respect to this issue, since in order to successfully employ an instrumental variables approach, we need a variable that influences food insufficiency status but not dietary intake.

Even though consumption was lower in food-insufficient households, the mean intakes of this group are above 100 percent of the RDA for a number of nutrients. Since the RDA's are set at a level that is intended to meet the needs of practically all healthy persons, if a population's habitual intake approximates or exceeds the RDA, the probability of deficiency is quite low (NRC/FNB, 1989). However, for five of the nutrients studied here – calcium, vitamin E, vitamin B-6, magnesium, and zinc – mean intakes are well below the RDA. In addition, for food energy, the mean intake is below the recommended energy intake. The nutritional significance of this shortfall is unknown for two reasons. First, as with all diet surveys there may be under-reporting in the CSFII and the extent of this under-reporting is unknown. Second, without knowing the distribution of intakes and requirements, there is no way to verify the probability of deficiency within a group.

However, our intent in this paper was not to assess the nutritional significance of food insufficiency. Rather, we set out to test whether self-reported indicators of food security, such as the USDA food sufficiency question, were useful in detecting group differences in intake and could therefore be reasonably added to the Nation's nutrition monitoring system. We do find that food insufficiency, net of other factors that affect diet, was significantly related to lower nutrient intakes.

[5] We included economic variables, such as income, in these regressions because it is reasonable to assume they have a direct effect on diet (e.g., through formation of dietary habits) that is independent of the indirect effect through food insufficiency. Omitting these variables from our regressions had very little impact on our results.

Overall, the findings presented here provide additional evidence of respondents' abilities to assess their household food sufficiency status and thereby further validate the use of self-reported measures of hunger and food insecurity. Such measures are likely to become an integral part of nutrition monitoring, especially at the local level. Due to shrinking budgets and the tendency toward decentralization, local responsibility for monitoring activities, as well as for nutrition service delivery itself, is likely to increase. In this environment, quick and simple hunger assessment measures will become more important, since they are much less costly than detailed dietary surveys. Our work in combination with other research in this area can provide added confidence in the usefulness of such measures.

References

Alaimo, K., and R.R. Briefel. "National Estimates of Food Insufficiency, NHANES III, 1988-91," presented at the 27th Annual Meeting of the Society for Nutrition Education, Portland, OR. July 16-20, 1994.

Basiotis, P.P. "Validity of the Self-Reported Food Sufficiency Status Item in the U.S. Department of Agriculture's Food Consumption Surveys," V.A. Haldeman, ed. *American Council of Consumer Interests 38th Annual Conference: The Proceedings*. Columbia, MO: American Council on Consumer Interests. 1992.

Bickel, G., M. Andrews, and B. Klein. "Measuring Food Security in the U.S.: A Supplement to the CPS, in *Nutrition and Food Security in the Food Stamp Program*. Washington, DC: Food and Consumer Service, U.S. Dept. of Agriculture. 1996.

Blaylock, J.R., and D.M. Smallwood. "An Alternative Approach to Defining and Assessing Poverty Thresholds," *Western Journal of Agricultural Economics*, 11:100-105. 1986.

Blaylock, J.R. "Evaluating Food Plans and Poverty Thresholds," *Applied Economics*, 19:1341-1352. 1987.

Briefel, R.R., and C.E. Woteki. "Development of Food Sufficiency Questions for the Third National Health and Nutrition Examination Survey," *Journal of Nutrition Education*, 24(Suppl):24S-28S. 1992.

Cristofar, S., and P.P. Basiotis. "Dietary Intakes and Selected Characteristics of Women 19-50 Years and Their Children Ages 1-5 Years by Reported Perception of Food Sufficiency," *Journal of Nutrition Education*, 24:53-58. 1992.

Federal Register. "Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program," 58:32752-32806. June 11, 1993.

Federation of American Societies for Experimental Biology, Life Sciences Research Office. Prepared for the American Institute of Nutrition. "Core Indicators of Nutritional State for Difficult-to-Sample Populations," S.A. Anderson, ed. Published in the *Journal of Nutrition*, 120:1559-1600. 1990.

Federation of American Societies for Experimental Biology, Life Sciences Research Office. Prepared for the Interagency Board for Nutrition Monitoring and Related Research. *Third Report on Nutrition Monitoring in the United States: Volume I.* U.S. Government Printing Office: Washington, DC. 1995.

Guthrie, H., and J. Sheer. "Validity of a Dietary Score for Assessing Nutrient Adequacy," *Journal of the American Dietetic Association*, 78:240-245. 1981.

Kendall, A., C.M. Olson, and E.A. Frongillo. "Validation of the Radimer/Cornell Measures of Hunger and Food Insecurity," *Journal of Nutrition*, 125:2787-2792. 1995.

Korn, E.L., and B.I. Graubard. "Epidemiologic Studies Utilizing Surveys: Accounting for the Sampling Design," *American Journal of Public Health*, 81:1166-1173. 1991.

National Research Council, Food and Nutrition Board. *Recommended Dietary Allowances*. 10th ed. Washington, DC: National Academy Press. 1989.

Perloff, B.P., R.L. Rizek, D.B. Haytowitz, and P.R. Reid. "Dietary Intake Methodology II. USDA's Nutrient Data Base for Nationwide Dietary Intake Surveys," *Journal of Nutrition*, 120:1530-34. 1990.

President's Task Force on Food Assistance, *Report of the President's Task Force on Food Assistance*. Washington, DC: U.S. Government Printing Office. 1984.

Pindyck, R.S., and D.L. Rubinfeld. *Econometric Models and Economic Forecasts*. New York: McGraw-Hill Book Company. 1981.

Radimer, K.L., C.M. Olson, J.C. Greene, C.C. Campbell, J.P. Habicht. "Understanding Hunger and Developing Indicators to Assess It in Women and Children," *Journal of Nutrition Education*, 24(Suppl):36S-44S. 1992.

Rose, D., J. Blaylock, and P.P. Basiotis. "Characteristics of Food Insecure Households in the United States," presented at the 122nd Annual Meeting of the American Public Health Association, Washington, DC. October 28-November 3, 1994.

SAS Institute, Inc. *SAS/STAT User's Guide, Version 6*. 4th ed. Cary, NC: SAS Institute Inc. 1990.

Sempos, C.T., N.E. Johnson, E.L. Smith, and C. Gilligan. "Effects of Intraindividual and Interindividual Variation in Repeated Dietary Records," *American Journal of Epidemiology*, 121:120-130. 1985.

Tippett, K.S., S.J. Mickle, J.D. Goldman, et al. *Food and Nutrient Intake by Individuals in the United States, 1 day, 1989-91*, Nationwide Food Surveys Rep. No. 91-2. Riverdale, MD: Agricultural Research Service, U.S. Dept. of Agriculture. 1995.

U.S. Dept. of Agriculture, Human Nutrition Information Service. USDA Nutrient Data Base for Standard Reference, Release 9 [data tape, accession No. PB90-502717]. Springfield, VA: National Technical Information Service. 1985.

____ . 1991 Continuing Survey of Food Intake by Individuals and 1991 Diet and Health Knowledge Survey [data tape, accession No. PB94-500063]. Springfield, VA: National Technical Information Service. 1992.

U.S. Dept. of Agriculture, Food and Consumer Service, and U.S. Dept. of Health and Human Services, National Center for Health Statistics. *Conference on Food Security Measurement and Research: Papers and Proceedings*. Washington, DC. 1994.

Wehler, C.A., R.I. Scott, and J.J. Anderson. "The Community Childhood Hunger Identification Project: A Model of Domestic Hunger–Demonstration Project in Seattle, Washington," *Journal of Nutrition Education*, 24(Suppl):29S-35S. 1992.

Wehler, C.A., R.I. Scott, J.J. Anderson, and L. Parker. Community Childhood Hunger Identification Project: *A Survey of Childhood Hunger in the United States.* Washington, DC: Food Research and Action Center. 1991.

_____ . *Community Childhood Hunger Identification Project: A Survey of Childhood Hunger in the United States*. Washington, DC: Food Research and Action Center. 1995.

Westat, Inc. *A User's Guide to WesVarPC, Version 2.0.* Rockville, MD: Westat, Inc. 1996.